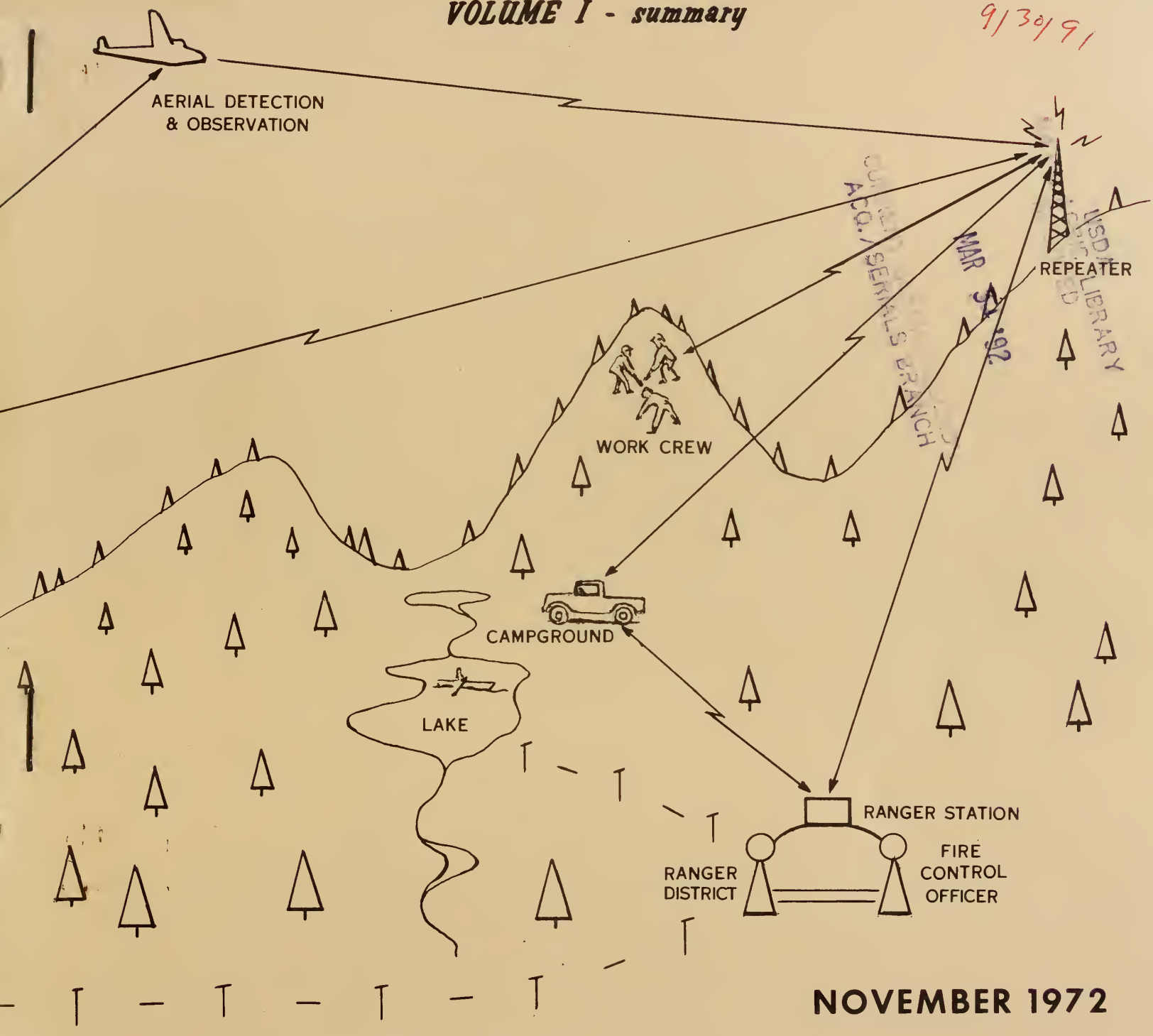
A STUDY OF

FOREST SERVICE

TELECOMMUNICATIONS

VOLUME I - summary



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FOREST SERVICE TELECOMMUNICATIONS* STUDY

VOLUME I

Main Study Recommendations and Findings

November 1972

*Telecommunications refers to a system of communications at a distance by electronic means.

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INTRODUCTION

This volume lists the major study recommendations, giving an overview of the study results. Justification statements, based on the study findings, accompany all but the large fire system design recommendations.

Because of the large volume of study materials, the study output is organized in several volumes, as follows:

Volume II:	Methodologies and procedures for evaluating telecommunication requirements and sample cost benefit analyses; analyses of radio replacement and maintenance policies
Volume III:	Telecommunications planning, organization, financing and management
Volume IV:	Design of Large Fire Communication Systems and analyses of Large Fire Communication requirements

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Acknowledgement

The study team was aided greatly in its work by a large number of individuals in the National Forest System. In particular, mention must be made of the highly cooperative attitude of the fire fighting personnel during the 1970 conflagrations in the Western United States and of the continuous cooperation provided by the Electronics Engineers in all regions.

The study team acknowledges the cooperation of these and others involved in the study with much gratitude.

STUDY OBJECTIVES

The objectives of the Forest Service Telecommunications Study were to:

1. Evaluate the management of the redio systems needed to satisfy the communication requirements of present and future Forest Service programs.

2. Provide methodologies and recommendations for evaluating requirements, financing procedures and organizational structures for electronics and communications management, taking into account alternative non-radio communication systems.

3. Provide solutions to some critical large-fire communication problems.

The study results and recommendations were formulated within the framework of the stated objectives.

SYNOPSIS

The growth in the size and complexity of the Forest Service's telecommunications systems has led over the years to problems which could not adequately be resolved by the existing organization and the available decision making aids. Specific problems arose from: (1) the need to evaluate systematically and consistently the requirements for telecommunication units or system modifications, including the justification of the existing number of units and systems; (2) the lack of operating rules and standards for telecommunication equipment and networks valid for application in the Forest Service; (3) the tasks, assignments, function, and organization through which present or future electronics engineers and technicians can adequately meet their responsibilities in the telecommunications field in the Forest Service; (4) the increasing difficulty in finding the means for financing present and future requirements in telecommunications.

These problems led to reviews and studies in Regions 3 and 4. The Region 3 study found that annual funding deficiencies had a cumulative effect, creating obsolescent communication and facility support systems. The Chief was asked to take a Service-wide look at the radio communication problem. The Region 4 study confirmed the same deficiencies, and recommended a WCF system to the Chief, as a means of correction.

Both Regional studies identified a rapidly accelerating demand for better communication systems to handle large fire situations (conflagrations).

The most significant findings of the present study are listed below:

1. The established Forest Service radio nets are operating on an average 1.4 benefit/cost ratio. They are a good investment and their existing value to the Forest Service is validated by this study. Additions to the system that meet the justification requirements set forth in this study should be fully considered in the annual planning, programming and budgeting cycle.

2. Forest Service radios are being furnished at an average per set cost equal to or less than a commercial telephone instrument (including FTS costs). Forest Service ownership is also providing the required level and quality of radio service at about 2/3 the cost of contracting out.

3. Benefits from existing Forest communication nets are derived through improved efficiency and effectiveness in Administration (48% of total benefits), fire presuppression (38%), and safety (14%).

4. A ten to twelve year replacement cycle will produce the highest returns from fire and/or administrative communication nets.

5. Existing Regional communication and electronics planning, and programming efforts should be consolidated into coordinated, Service-wide annual and multi-year plans.

6. Communications and Electronics program managers are essential at the Regional and Washington levels. They are needed to coordinate accelerating demands for more and better communications and electronic applications into Service-wide summaries and action plans.

7. Additional professional electronic engineering expertise needs to be provided at the Regional level for improving system planning and design capabilities.

8. There is no evidence that prescheduled preventive maintenance checks of radios decrease the probability of future breakdowns. Thus, a shift towards corrective maintenance as breakdowns occur should eventually require proportionately less technician time. This saving in technician time may permit a gradual strengthening of professional engineering without a significant decrease in technician capabilities.

9. During the last decade of austerity, annual funding deficiencies for communications and buildings have accumulated into multi-year deficiencies. Needed replacement of both buildings and communications has been delayed and many Forest Communications Systems are old and obsolete (14.2 years average Service-wide age).

10. Demand for separate communication nets for large multiple fire situations has accelerated. The potential for losses of life and personal property from conflagrations is increasing.

11. Existing procedures for financing the communications and electronics activity are not fully responsive to high priority field requirements.

When implemented, the study should help to:

a. Minimize total system costs by focusing attention on obsolescence costs and reduced preventive maintenance requirements.

b. Establish the positive investment value of Forest Service radio telecommunication systems.

c. Strengthen program and technical direction for the communications activity by emphasis on the need for communications managers at regional and Washington Office levels.

d. Contribute to a more stable financial base by separating replacement funding requests from construction funding requests.

e. Make the communications planning process more directly responsive to user needs.

f. Provide a reliable and adequate telecommunication system for use on large and severe multiple fire situations.

MAJOR IMPLICATIONS OF STUDY RECOMMENDATIONS

Capital Expenditures

A. The annual funds required to sustain an efficient and effective communications and electronics program, based on a summary of estimates prepared by the Regional Electronic Engineers for Fiscal Year 1973 budgetary planning (see Volume III, Appendices), are (under a 10 year replacement program):

Annual replacement costs (10 yr. cycle)	$1,867,000
Annual maintenance costs (reduced by 15% for shift to breakdown maintenance).	$3,472,000
New construction	$ 323,000
Estimated backlog of obsolete components, spread over 10 years	$ 635,000
TOTAL	$6,297,000

The estimated F&GP and FA&O annual funding needs, based on the above estimates, are:

Total reduced by 16% (amount now being obtained from other Regional project funds).	$5,289,000
Plus estimated amount for annual W.O. communications and electronics and R-10 costs	$ 580,000
Estimated F&GP and FA&O annual funding need	$5,869,000

For comparison, the total expenditures, from all sources, in fiscal year 1970 for the entire Forest-Service owned and operated radio communications network (construction, maintenance and replacement) was $3,420,759. This amount represents 54 percent of the total estimated requirements for fiscal year 1973 of $6,297,000. (The figures include all regions except Region 10, and do not include W.O. management assessments of approximately 5%.)

The Administration's budget for Fiscal Year 1973 (Revised 1/31/72) included an estimated $7,532,000 for maintenance of fire and general purposes (F&GP). Construction for fire, administration, and other purpose is $1,958,000 (FA&O) for a total of $9,490,000. If financed for the full amount estimated, communications and electronics would require 66% of the total gross amount of the recommended F&GP and FA&O budget.

B. The implementation of the proposed large fire communication system will necessitate outlays for:

1. Initial investment (including management assessments) of $3,646,528 (plus cost of converting Region 1 airnet to service-wide airnet frequency).

2. Maintenance costs: The maintenance costs of the proposed National Radio Fire Cache are expected to equal the combined maintenance costs of the existing regional and central radio caches which it is designed to replace.

3. Replacement costs: Cost of replacement at recommended intervals will approximately equal the original cost of the system less salvage costs.

The enumerated costs of the large fire system may be offset somewhat by the reduction in the costs of regional fire caches and by the availability of the present airnet portable units for other uses. The benefits derived from the implementation of the large fire communication system are manifold. Chief among these are (1) increased reliability of communications during fire line emergencies, (2) increased efficiency of fire suppression personnel, (3) improved air attack coordination, including air attack during the initial fire suppression states, and (4) improved service to large fires. The present communication system is inadequate for large fire generated communication traffic loads.

Manpower Needs

The implementation of the proposed program may require an increase in the number of communication managers and engineers in the communications and electronics organization. A future reduction in technician tasks is possible due to task redistribution among communication managers, engineers and technicians along with the proposed changes in maintenance policy. Under the proposed modifications, the growth in communication systems on the forests should not require a corresponding growth in technician manpower.

Manpower ceilings are apparently going to continue for the Forest Service for an indefinite period. By shifting from a preventive maintenance to a breakdown maintenance schedule, it appears that the communication and electronics organization as a whole may be able to make the recommended shift in the ratio of professional electronic engineers to electronic technicians without any significant increase in total manpower.

MAIN RECOMMENDATIONS

AND

FINDINGS

RECOMMENDED MISSION STATEMENT

FOR THE COMMUNICATIONS AND ELECTRONICS ORGANIZATION

1. Provide technical assistance in the planning and evaulation of alternative electronic systems for (voice and non-voice) data transmission and coordinate their uses.

2. Design, implement, manage, maintain and improve non-commercial electronic transmission systems.

3. On request, consult on or prepare designs for other applications of electronic technology to aid Forest Service programs and evaluate such applications.

4. Accomplish Department-wide and special departmentally delegated responsibilities.

The recommended mission statement gives recognition to the increasing use of electronic data transmission services by various functional branches of the Forest Service. The expected proliferation in communication requirements creates the need for coordination and technical assistance in the selection of alternative modes of transmission service. The first item of the mission statement makes this an explicitly recognized function of the communications and electronics organization. Items two, three, and four restate the traditional role of the Communications and Electronics Branch. In addition, item two stresses the management and design responsibilities of the organization for the Forest Service operated system.

RECOMMENDED STATEMENT OF OBJECTIVES

FOR FOREST SERVICE COMMUNICATIONS SYSTEMS

The Forest Service telecommunications systems should serve one or more of the following objectives:

1. Contribute to employee safety and minimize consequences of injuries.

2. Contribute to public safety and aid the public in emergencies.

3. Aid in fire prevention, detection and suppression.

4. Increase effectiveness of Forest Service personnel and minimize cost of resource management.

The recommended statement of objectives is based on the recognition that the evaluation of communication requirements and of the system as a whole must be based on a clear statement of the objectives for the system. A present weakness is the lack of a uniformly accepted role for the system. This is true especially in the case of the role of the Forest Service communications systems in aiding the public in search and rescue type emergency operations.

The degree to which the stated objectives can or should be satisfied is relative to the level of public aspirations and available technology.

RECOMMENDATION 1 --REPLACEMENT POLICY

> A replacement cycle of ten to twelve years for the Forest Service radio communications systems, based on minimum system cost considerations, is recommended for system replacement and renovation at the present time.

Forest Service owned and operated communication systems are at present under no established replacement policy. As a result, many of our systems are costlier than necessary when obsolescence costs are included in the total cost calculations. Obsolescence costs are those costs attributable to unutilized advantages in operational, maintenance and installation characteristics of new equipment over that in use.

Identified, prorated radio equipment obsolescence costs associated with differences between 1970 type equipment in power requirements, installation and maintenance, costs are $72 annually, per item of equipment (Vol. II). This figure does not include cost savings due to weight reduction, signal power output, number of available channels, etc. Such additional cost savings, though harder to measure, may be equal to or larger than the above identified amount. Assuming these additional cost savings to be equal to the calculated costs, a saving value of $140 has been used as the upper obsolescence cost level in the replacement policy cost calculations. Obsolescence costs of $105 represent the mid point value which has been accepted by the study group as most representative of actual obsolescence radio costs at the present time.

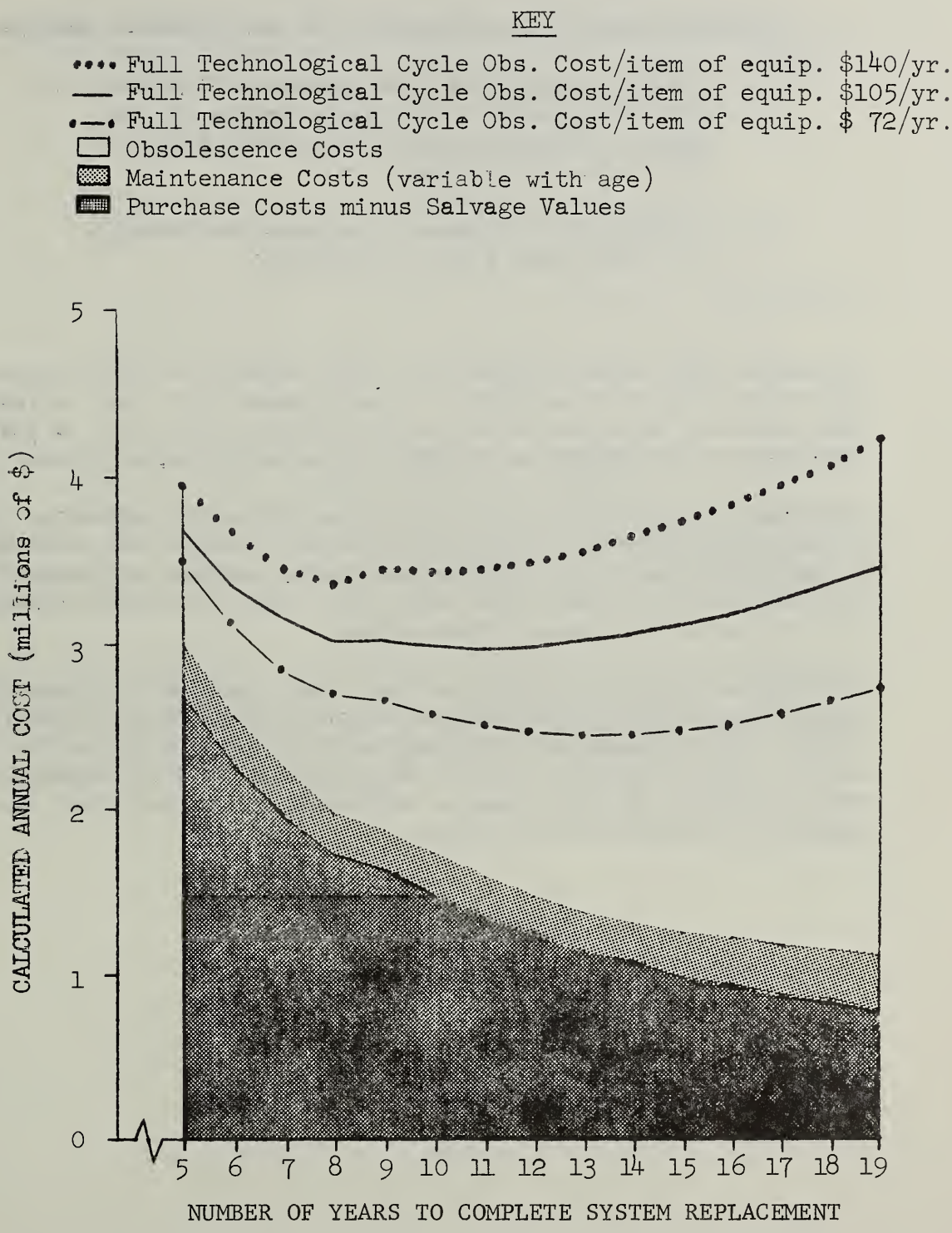
Figure 1, page 15, shows the impact of various replacement policies on annual system costs for the three obsolescence cost levels discussed above. The replacement policies range from a complete system replacement every 5 years to a complete replacement every nineteen years. Under each policy, an equal part of the total system would be replaced each year.

While the annual purchase costs decrease continuously and the age variable maintenance costs remain relatively stable over the range of policies considered, the annual obsolescence costs gradually increase to the point where reductions in purchase costs are offset by obsolescence cost increases.

The figure shows optimum replacement cycles of thirteen years for the full annual obsolescence cost of $72 per equipment item and ten years when full obsolescence costs per item amount to approximately twice this value ($140), and full salvage values are not realized, or eight years if full salvage values are realized. A replacement cycle of eleven years is optimal for a full annual obsolescence cost of $105 per item of equipment.

The loss associated with longer replacement cycles depends on per item obsolescence costs and on displacement from optimum policies. For a 15 year replacement policy the annual system cost would increase by $128,000 by comparison with the 11 year cycle (obsolescence costs $105) and by $305,000 a year over the 10 year cycle when obsolescence costs are $140. A realistic replacement policy thus may result in substantial savings in addition to providing better communication facilities for the Forest Service. (For a fuller discussion see Vol.II).

Fig. 1 Calculated annual Forest Service radio communication costs under different replacement policies*



* Computations based on 22,000 pieces of equipment distributed by type as follows: Fixed Stns. 15.75%, Mobile Radios 30.15% and Portable Radios 54.10%.

RECOMMENDATION 2 -- PLANNING PHASES

Planning should be accomplished in two distinct phases:

a. a major systems replanning phase coinciding with the planned replacement period for the system. (For example, ten to twelve years for the Forest System)

b. a yearly review phase to augment and modify the long range plan as necessary.

Presently, new communication plans are required at three year intervals. There is no tie to a replacement cycle and in practice this planning is accomplished perfunctorily if at all. A yearly inventory of equipment is usually the major planning effort.

The recommendation reduces the planning effort by extending the planning period from three to ten (twelve) years. The replanning is undertaken only when system replacement action is imminent. The yearly review need cover only those items for which changes are indicated by current forest plans.

Questionnaire replies indicated that about half of the Rangers and Supervisors felt current communications planning did not meet their needs. The proposed approach agrees with planning efforts now in use for most functional areas. The planned level of communications should meet the forest needs as expressed in its long and short range multi-functional planning.

RECOMMENDATION 3 -- MAJOR SYSTEM REPLANNING

Major system replanning should be done jointly by the user (Ranger and Supervisor in the case of the forest system) and the regional Communications Engineers and should:

a. Re-evaluate contributions of existing system.

b. Evaluate requirements contained in (approved) functional and multi-functional long range plans.

c. Consider alternative ways of satisfying the requirements.

d. Incorporate applicable technological developments.

Planning is the responsibility of the National Forests. They frequently do not have the planning expertise needed at the forest level to fully accomplish this task. Thus, the forest plans may be modified by the Regional Engineers without full consideration of the forest requirements. This sometimes results in dissatisfaction at the user level.

The proposed recommendation requires joint replanning. Recommendation items a and b are based primarily on user inputs; items c and d, on the other hand, require strong professional engineering assistance. A joint effort will therefore produce a better plan with less possibility of being unbalanced in either direction.

RECOMMENDATION 4 -- YEARLY REVIEW

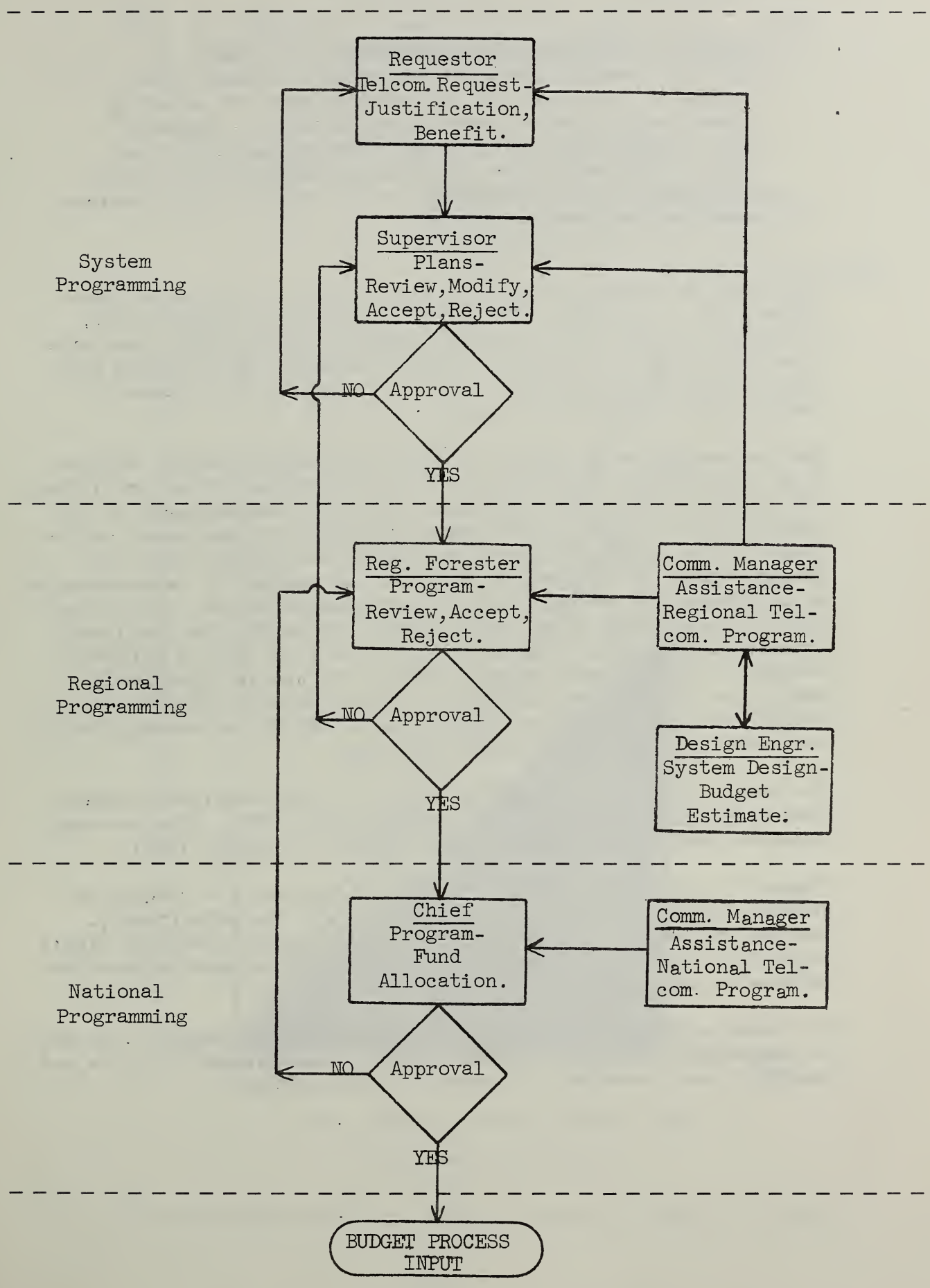
> The yearly review phase should be done for a region as a whole using forest or other communication system plans and the functional work plans of the units as input. Proposed system modifications and system additions should be evaluated for their contribution to the communication system objectives in this planning phase.

Yearly consideration of communications needs is usually expressed in the annual inventory and requisitions for new equipment.

It is proposed to expand this into a yearly review that would define needs for the ensuing 3 to 5 years as expressed in the short range functional and multi-functional work plans. This review will require a consideration of communication needs as the functional work plans are developed assuring regular acquisition and implementation of the needed communication facilities. The yearly review will also permit timely responses to operational management decisions at all levels (Fig. 2, page 19).

The proposed system should be of substantial assistance in eliminating the deficiencies reported in the study questionnaire. Of the 55 responding district rangers, 26% reported lack of coverage of their important work areas with resulting losses up to $1400 per district per year. Additionally, 28% did not have the capability to direct air tanker drops and 49% felt communications shortages limited utilization of employees during high fire danger. While these deficiencies may not be due entirely to lack of planning, adequate planning should have reduced the high levels of the observed deficiencies.

Fig. 2 Generalized telecommunication evaluation and implementation process



RECOMMENDATION 5 -- REQUIREMENTS EVALUATION

> Evaluate communication requirements on the basis of costs and benefits associated with such systems. New systems and additions to, or modifications of, existing communication systems, should be evaluated. (Replacement of established systems with new equipment does not require a re-evaluation of the costs and benefits of the entire system; only components which clearly appear marginal should be re-evaluated.)

The proposed planning procedures will require a continuous input of measures of benefit, both quantifiable and non-quantifiable, to provide a basis for the system planning process and to maintain a continuing base of regional (forest, station) and national measures of benefits associated with the communication systems to justify their use and development.

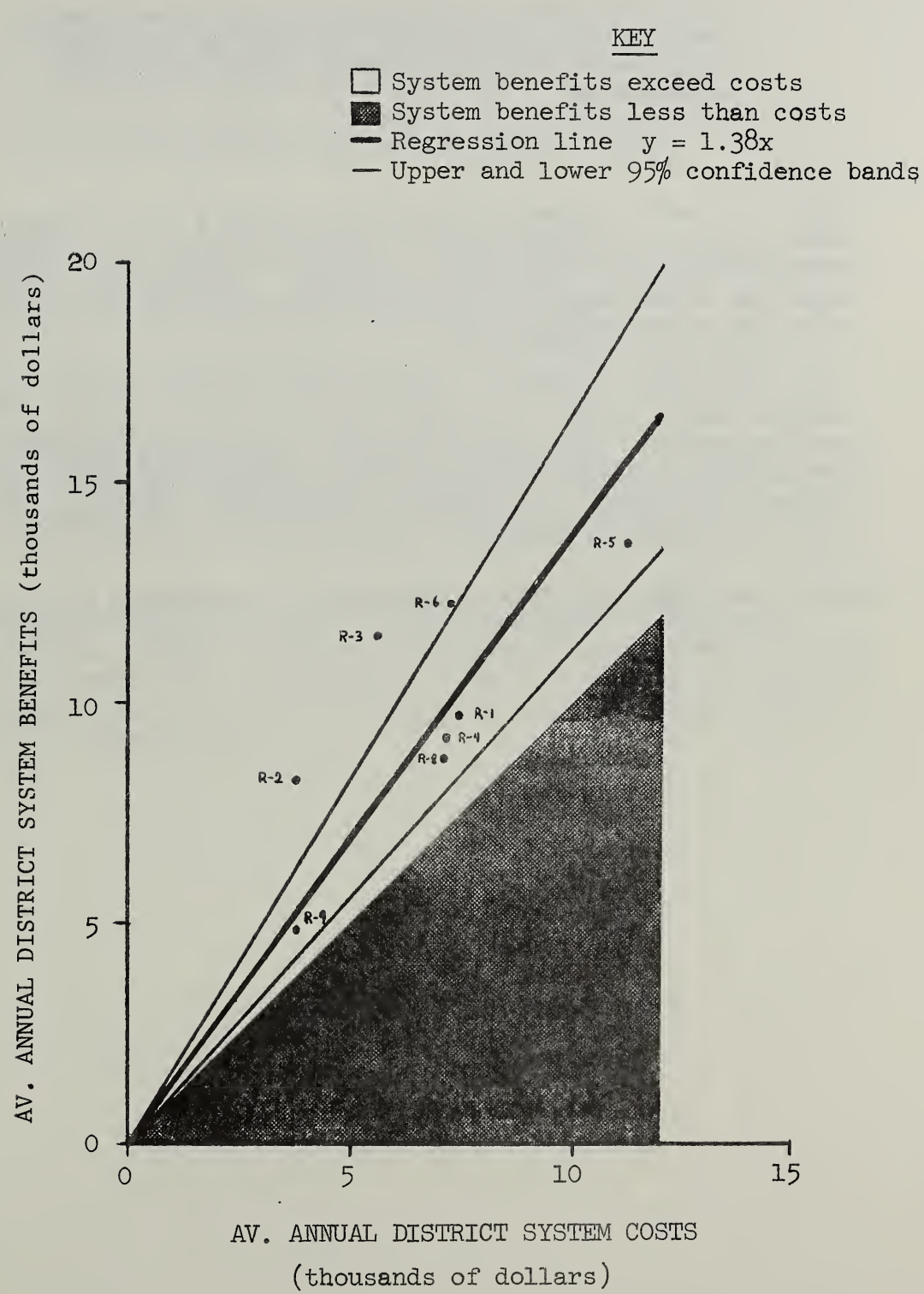
The recommendation is based, in part, on a sample benefit evaluation of presently established field radio systems which established the feasibility of such procedures. The non-random sample of 63 ranger districts used in the study, selected to some extent on the basis of the scope and type of functional activities from a 25 percent sample of national forests in each region, is representative of districts with average and above average workloads. For these districts the study showed benefit/cost ratios for the field radio communication systems ranging from 1.14 to 2.15, with a weighted average of 1.42 (sample average 1.38). The average (weighted) yearly cost of the sample district radio system was found to be $6,850; the average yearly benefit was $9,750 for an average yearly net benefit of $2,900 per sample district.

The sample radio system benefits were due to non-emergency management used (40%), telephone toll charge savings (8%), fire pre-suppression radio uses (38%) and contributions to safety (14%).

Figure 3 on page 21 shows the regression (through the origin) of average regional district benefits on costs. The relationship, showing increasing benefits with increasing system costs, is highly significant and was obtained with benefit data gathered without reference to systems costs.

The detailed discussion of sample system costs and benefits, as well as suggested procedures applicable for the measurement of costs and benefits, are presented in Volume II of this study.

Fig. 3 Regression of sample district communication system benefits on system costs*



*Cost estimates based on regional values-including structures.

RECOMMENDATION 6 -- FOREST SERVICE OWNERSHIP OF RADIO SYSTEM

> Existing types of Forest Service radio equipment should continue to be Forest Service owned and maintained rather than rented (with or without maintenance).

Rental of radio equipment without maintenance for a minimum of three years is, on the average, twice as expensive as Forest Service ownership of the same equipment. Rental for a period less than three years significantly increases the ratio in favor of Forest Service ownership.

Rental of radio equipment with maintenance still favors Forest Service ownership for an average gain of forty percent smaller costs per year. Additionally, rental with maintenance would (a) very significantly increase the equipment unavailability ratio, (b) provide no emergency field service nor adequate technician services for fire.

Rental and ownership cost comparisons are discussed in Volume II.

RECOMMENDATION 7 -- TELECOMMUNICATION MANAGERS

> Designate a telecommunications manager at the Washington Office and at each region. Provide capabilities at all levels to satisfy the management responsibilities of the branch in accordance with the recommended mission and role statements.

The development and administration of communications management processes needs strengthening, both in the Washington Office and in the regions, if a more intensive program of management is to evolve. The designation of communication managers with this responsibility is perhaps the most needed organizational change at this time.

This recommendation requires the establishment of a management position at the Washington Office to monitor and coordinate service-wide inventories, planning, organizing, staffing and budgeting, and to develop and maintain a communications management system.

Similarly, this recommendation requires the establishment of regional manager positions with the expertise and delegated authority to inventory, plan, design, construct, maintain, replace, and/or modify the Forest Service radio systems that will meet the stated and approved requirements set by line officers and to provide technical assistance in other areas.

RECOMMENDATION 8 -- PROFESSIONAL STAFFING

Strengthen the ability of the Regional Branch of Communications and Electronics to:

1. Assist line units such as National Forests in communications planning, system evaluation, maintenance and operation.

2. Design individual systems including hardware and operational specifics.

3. Develop procedures for planning, evaluation, design, maintenance and operation of systems.

The Regional Electronics Branch has, at present, been expected to do the professional portions of the forest communications job, not fully recognized in branch staffing levels. Therefore, if combined professional forest and regional jobs amount to more than a man-year, additional professional electronic engineers should be placed at the regional office to assist the Regional Electronics Officer as the workload requires.

The Regional Electronic Engineers have also assumed most of the responsibility for system design and engineering. Increasing demands, and the need to develop standards for efficient systems warrant centralization of the system design to the regional level (this does not preclude the possibility of inter-regional central system design, if of benefit).

RECOMMENDATION 9 -- WASHINGTON OFFICE ACTIVITY ASSIGNMENT

> The Branch of Communications and Electronics should continue to operate in the Division of Administrative Management at the Washington level.

The activity could be assigned to the Deputy for National Forest System or to the Deputy for Administration.

Under the Deputy for National Forest System, the activity could be administered by Directors of either the Division of Engineering or the Division of Fire Control.

Assignment under the Division Director for Fire Control may orient telecommunications too heavily towards Fire Control with insufficient attention to administrative needs.

Assignment under the Director of Engineering has definite short term advantages. The mere size of the engineering organization would tend to make more resources available to the telecommunications activity. Engineers are also in the business of providing support services to line managers, which is also the objective of telecommunication services.

Looking to the future, however, it is obvious that communications of all types (ADP, data transmission, telemetry, conference and simple voice links, etc.) are going to play an increasingly important role in management. With this increased dependence on all types of communications, there is a reasonable probability that all phases of communications will need to be placed under one central manager at the Washington Office level. This could be a separate branch, or possibly a division of communications. It should pull together all phases of communications that are now scattered among Administrative Services, Fire Control, Engineering and Administrative Management (ADP, Beltsville, etc.).

The Deputy for Administration is the indicated place for such a consolidation and the telecommunications activity should therefore remain in the Division of Administrative Management.

RECOMMENDATION 10 -- FINANCING

Modify the existing procedure by separating the P&M maintenance line item for fire and general purpose (F&GP) improvements into (a) maintenance of fire and general improvements (structural), and (b) replacement and maintenance of radio and/or electronic systems.

Buildings for communications, antenna tower construction and additions to established communications systems should be retained in the "no-year-end" construction item for fire, administration and other purposes (FA&O).

This recommendation is designed to remove Communication System replacements (by same or different equipment) from the area of construction and thus to provide more stability to the Forest Service communications program.

Traditionally, financing for communications has been included in a single P&M line item for Fire and General improvements. The original rationale for doing this was fully justified because communications and structural facilities were all part of a basic system of support (Forest Service owned telephones and buildings) for protection and development activities. Over a period of time, the practice has created some cumulative deficiencies in funding both structural improvements and field telecommunications.

Construction programs can and probably should continue to be the logical ones to be reduced in times of austerity. Yet, the maintenance and replacement portion of any basic supporting system should have relative stability to provide continuing long-term quality service. The need to strengthen this concept is apparent in the F.Y. 1971 Interior and Related Agencies Appropriation Bill whereby maintenance and construction line items were separated for the first time. Construction funds were granted a no-year-end carry over status.

RECOMMENDATION 11 -- PREVENTIVE MAINTENANCE PHASEOUT

> Phase out preventive maintenance of radio equipment following a test period to substantiate the present study findings. (Preventive maintenance denotes periodically scheduled maintenance performed on operating equipment.)

A statistical analysis of historical maintenance data (69 forests and 520 pieces of radio communications equipment) has indicated no significant difference in the breakdown rate between equipment operating under once and twice per year schedules of preventive maintenance.

The evidence strongly indicates that the breakdown rate is independent of preventive maintenance frequency. Consequently, a strong case can be made for the elimination of preventive maintenance (for a detailed discussion see Vol. II.) However, no data were available on equipment operating with no preventive maintenance. Therefore, an implementation plan which includes a test to substantiate the present conclusions through the direct observation of the effects of the elimination of preventive maintenance is desirable.

Operational maintenance should continue to be performed. Operational maintenance is defined as non-scheduled maintenance with the objective of assuring the equipment is operating properly and ready for use.

RECOMMENDATION 12 -- UNACCEPTABLE NETWORK CONGESTION LEVELS

> Voice radio communication congestion levels exceeding probabilities of .66 should be considered unacceptable on all multistation voice radio communication networks when such occur repeatedly and over extended time periods (one hour or longer at a time).

When the probability of congestion reaches .66, serious deterioration of service begins to be experienced by users of multistation voice radio networks. At this level of congestion continuous operations cannot be adequately maintained. For good service the level of congestion should be at, or below, a probability of congestion of .4.

Approximately 80 stations placing one call of 30-seconds duration per hour will produce a congestion level of .66. Under such circumstances, the average delay in placing a call exceeds one minute, producing operator frustrations and loss of calls.

The recommended standard is considerably below that required for commercial communication systems and is suitable only for systems which permit continuous monitoring of congested channels. For a more detailed discussion, see "Forest Radio Net Operating Characteristics", Parts I and II, Management Sciences Staff, 1969 (references shown in Volume IV).

RECOMMENDATION 13 -- STREAMLINING OF CODE PROCEDURES

The Forest Service should adopt the 10-code for exclusive use and should limit the overall number of codes used to 20. Eleven high use 10-codes should be among those memorized and used by all Forest Service radio users in addition to a newly devised code. The new code should express the message: Can you read me? (Did you read me?).

Code:	Message
10-1	Receiving poorly
10-4	O.K.
10-6 (10-23)	Standby
10-7	Out of Service
10-8	In Service
10-9	Repeat
10-13	Weather Information
10-19	Return (or I am returning) to station
10-20	(What is your) location? (My) location (is)
10-26	Routine check-in
10-33	Emergency Traffic (this station)
Assign code	Can you (did you) read me?

The 10 code is in universal Forest Service use and dominates over the 4 code 3:1 for administrative and 4:3 for fire use. Most 4 code messages used by Forest Service personnel are redundant (identical 10 code messages).

Of the questioned Forest Service personnel, 75% can readily remember only 20 codes or less. The same percentage of personnel prefers the use of a word over a code if it is equally brief and the meaning is equally clear.

RECOMMENDATION 14 -- MANAGEMENT SYSTEM

> The mission and objectives statements, together with recommendations in Volumes I through IV, as approved by Chief and Staff, should be incorporated in Forest Service Directives to specify the proposed management system.

The Communications and Electronics activity should receive strong management direction to obtain the full benefits of telecommunication applications. This management must be applied at all levels, but the major emphasis must come from a Washington Office communications manager working through annual and multiyear planning cycles.

RECOMMENDATION 15 -- LARGE FIRE COMMUNICATION SYSTEM

Provide the following facilities to serve the communication needs on a large fire, freeing the forest net for regular communication use:

1. Two ground communication networks (part of National Radio Cache System)

   a. A command network to serve division boss and above (including air attack boss and air tanker boss, for fire line to air coordination requirements), fire camp, spike camps and heliports.

   b. A tactical network to serve sector boss and below (including helicopters).

2. Multichannel aircraft radios, with pilot and operator access to any Forest Service or cooperating agency high band FM channel (150-174 MHz), for air attack control communications between aircraft.

3. Present air net facilities for transmitting long range support and dispatch instructions among the air dispatcher, air base, slurry base and aircraft.

4. A radio channel that can be accessed with VHF-AM multicom radios, normally installed in public and private aircraft, for use as a universal air emergency channel over large fires.

5. Long range repeater type radio service networks in the National Radio Cache System for use when telephone is not available at reasonable cost.

6. Slow speed facsimile equipment capable of operating over either a switched network telephone line or an FM radio channel in the National Radio Cache System.

7. Rotary (hunting) system telephone call routing at the headquarters end when more than one large fire or multiple zoned fire is being supported from a command, supply, and finance headquarters.

8. Telephone patches in the National Radio Cache System for patching, whenever possible, the radio service nets into the commercial telephone system.

9. Low cost, hand-held, short range radios in the National Radio Cache System for intra-camp communications.

10. A public address system for use at the main fire camp.

Figure 4, Page 33, illustrates the large fire system based on the above recommendations.

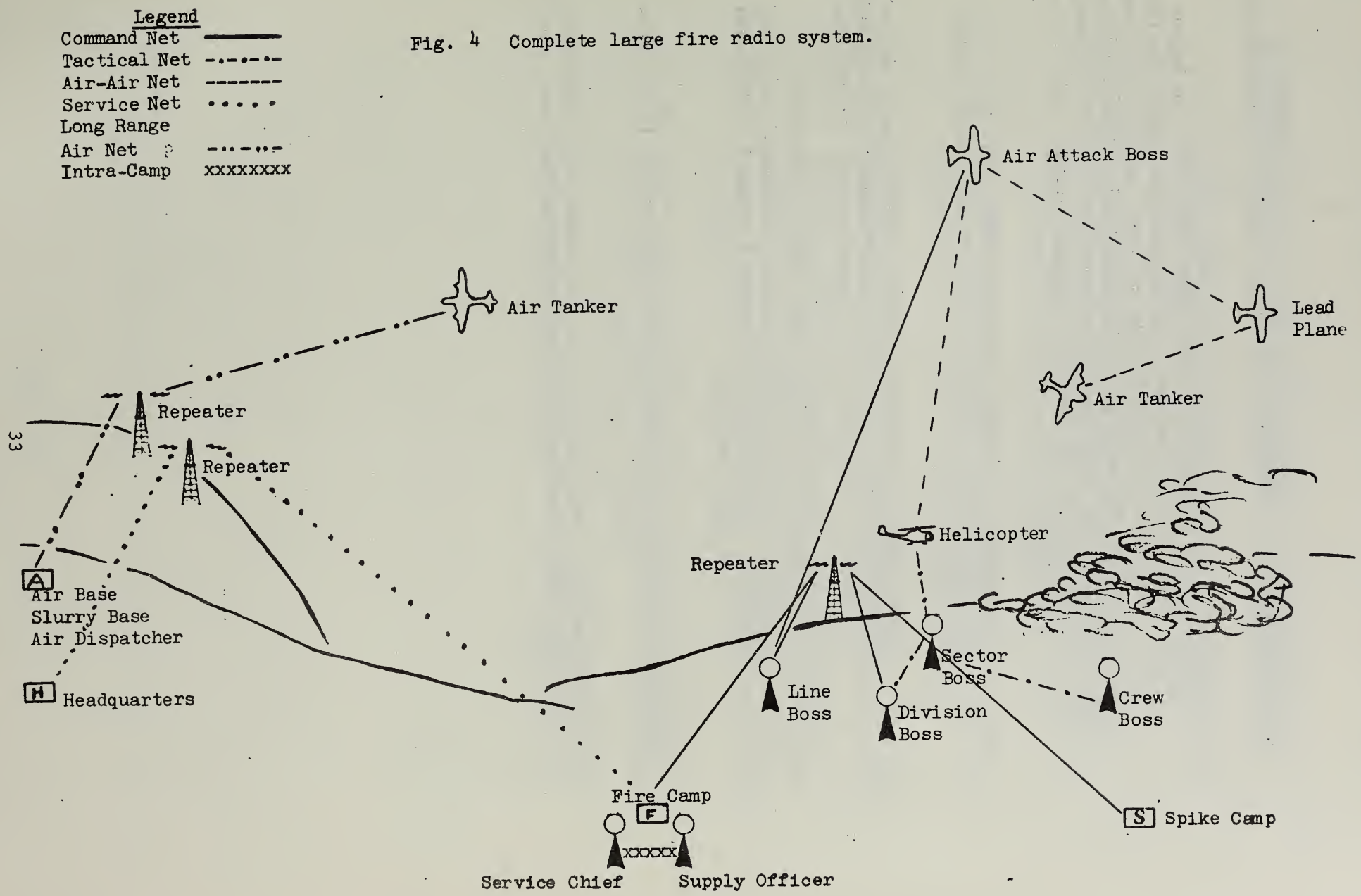


Fig. 4 Complete large fire radio system.

RECOMMENDATION 16 -- COOPERATOR AND GROUND TANKER COMMUNICATIONS

Use equipment freed from present fire caches by the implementation of the new National Radio Cache to improve initial attack communication capabilities on four southern California forests before the arrival of National Radio Cache equipment to the fire. Use one separate repeater channel (2 frequencies) and provide 410 of the available portable radios for assignment as follows:

1. One hundred and twenty radios (PT 300's, PT 400's) for use with large (class 1 and 2) Forest Service owned ground tankers.

2. Ninety portable radios (HT 200's), with repeater operation capabilities, for Forest Service overhead use to maintain contact with cooperators and ground tankers on the fire.

3. Two hundred hand held portable radios (HT 200's or PT 300's), with repeater operation capabilities, for cooperator overhead use to maintain contact with Forest Service overhead on fire.

Provide additionally four AC utility sets for use by forest dispatchers.

This recommendation can be implemented only after the recommended National Radio Cache becomes fully operational at the level specified in this study.

RECOMMENDATION 17 -- LARGE FIRE COMMUNICATION MANAGEMENT

1. A GHQ communications officer should be assigned when multiple large fires are handled from a central location (GHQ).

2. In all cases, a Fire Communications officer should be assigned to a large fire. (The technical supervision should be by the GHQ communications officer if a GHQ organization is established.)

3. A communications installation and maintenance technician should be assigned to each fire camp under the supervision of the fire communications officer.

4. A radio operator should be assigned to each fire camp under the supervision of the fire communications officer.

5. A communications equipment supply clerk should be assigned to GHQ supply to assist in obtaining communication equipment supplies. (This should be an electronics technician familiar with the jargon and sources of communications equipment supply.)

6. An air communications officer should be assigned to work at the airbase under the technical supervision of the GHQ Communications Officer.

7. Job descriptions, training plans, and performance evaluation criteria should be designed and used.

RECOMMENDATION 18 --FINANCING OF LARGE FIRE COMMUNICATION SYSTEM

A one-time appropriation should be requested for full implementation of air attack and National Radio Cache System.

A one-time appropriation should also be requested to modify the air net system frequencies in Region 1 to comply with the air to ground support recommendations.

The estimated costs of implementation of the air attack system and National Radio Cache System are as follows (including management assessments):

- Multichannel Radios @ $4000 (268)	$1,531,429
- 6-channel radios @ $2000 (192)	548,571
- Installation @ $1000 (223)	318,571
- 9-channel portable @ 650 (871)	808,786
- 9-channel base @ $1000 (30)	42,857
- Repeater and hardware @ 1500 (15)	32,143
- Remote control @ $300 (48)	20,571
- Extended control @ $150 (72)	15,429
- Central control console @ $1000 (15)	21,429
- Short-range portable @ $60 (180)	15,429
- Public address system @ $300 (15)	6,429
- UHF base @ $2000 (18)	51,429
- UHF repeater and hardware @ $3000 (9)	38,571
- Telephone patches @ $200 (9)	2,571
- Facsimile terminals rentals 3 months per year @ $120 (18)	3,086
- Telephone wire @ $5 (192)	1,371
- Frequency conversions of present equipment	35,714
- Packaging, marking, and miscellaneous	28,571
Sub Total (including management assessments)	$3,522,957
- Installation and frequency change of present fire cache equipment for use in Southern California	123,571
Initial Investment Total	$3,646,528

Note: The present Radio Fire Caches (central and regional) contain 1154 ground and 84 air net radios. Of these, 584 are obsolete and 425 transferable for use in Southern California. The proposed National Radio Fire Cache would be composed of 1158 ground and 90 air radios.

The present total air net radios in Forest Service owned and contract planes number 329. The proposed number of aircraft radios is 223.

HISTORY OF THE PRESENT FIELD TELECOMMUNICATIONS SYSTEM

With the establishment of the National Forest System in the early 1900's, the need for more access to remote Forest areas and a better system of communications to administer Forest units developed. Early National Forest administration was highly protection oriented. A basic system of trails and/or primitive roads was first needed, and soon developed. Fire and administrative communications were, by necessity, sent by messenger.

The telephone was perfected during World War I. This communications tool was then introduced to supplement and eventually replace handcarried written or verbal messages. In the 1920's, a complex system of primitive roads, an elaborate network of trails, and thousands of miles of ground return telephone line were constructed. Investment records show the Forest Service owned 53,995 miles of telephone line in 1935.

The depression of the 1930's and its accompanying Civilian Conservation Corps program helped accelerate the development of the National Forests and Research and State and Private Forestry activities. By the early 1940's, a highly effective primitive road, elaborate trail network, Forest lookout, and ground return telephone complex reached its peak development. Civilian Conservation Corps labor had been used to construct most of this complex. For a few years they helped maintain the system. Practically every Forest Officer carried a portable phone set so he could hook onto a line and call where needed. Recorded on the investment records in 1940 were 63,125 miles of telephone line.

World War II ended the Civilian Conservation Corps program. The national attention was concentrated on the war effort from 1941 through 1945. Funds for development and maintenance programs of National Forests diminished accordingly. Meanwhile, the lookout, road, trail, ground telephone line complex deteriorated because of insufficient maintenance. The complex system was not efficient without the availability of cheap Civilian Conservation Corps labor.

Technology again advanced rapidly, particularly during World War II. This was especially true in the electronics field. Efficient and complex radio and radar systems were developed and utilized during the war. Forest Service equipment (SPF radios) designed by the radio laboratory was adapted and used by the military.

As would be expected, various types of military radio systems were adapted to civilian use soon after the war. The Forest Service quickly placed more advanced types of radio systems into service. These initial radios were used primarily to supplement the existing Forest Service ground-return telephone system and to provide communications into heretofore inaccessible National Forest areas.

It soon became apparent that early radio systems were more efficient (less costly), although possibly less effective (less dependability in system) than to maintain the many miles of ground return telephone lines. In addition, the radio gave immediate communications to major projects such as timber camps, insect control projects, project fires, and to mobile vehicles. By the early 1950's, the ground return telephone lines were on their way to being replaced by radio systems; 56,627 miles of telephone lines were recorded on the investment records in 1950 and 7,482 miles were recorded in 1969.

Today (1971) the Forest Service is composed of three major entities: (1) the National Forest System, (2) State and Private Forestry, and (3) Forest Research.

Communications from the Washington Office to Regional, State and Private Area, and Research Station offices are adequately provided via commercial facilities (memos, telegrams, telephone and ADP leased lines). The Forest Service pays the necessary funds to obtain the needed services by budgeting annually for them.

Communications from Research Station headquarters to Research field units and from State and Private Area offices to local governmental offices are also adequately provided by commercial facilities (mail, telephone, etc.). However, some communications, starting from the Regional offices to the Forest Supervisor offices, District Ranger offices, mobile units and Research field units, and almost all communications from District Ranger offices to field locations, fire camps and mobile units cannot be satisfactorily handled

by the usual commercial communication facilities. Consequently, the Forest Service was required to provide an in-house field telecommunications system or to contract for the construction and maintenance of a similar system from commercial sources. By choice and because of historic and economic considerations, an in-house field telecommunications system has been developed.

The in-house system has developed primarily because of a need for the Forest Service to have a reliable but highly mobile system of field communications during periods of high fire hazard in relatively remote areas. Because of this remoteness, and because of the need to keep the system at a peak performance level for fire, the Forest Service has been a pioneer in the development of mobile radio systems. The necessary technical competence had to be developed in-house. Commercial sources are either non-existent or their services are economically prohibitive in almost all instances.

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